

## WEANER PIGS FED GRADED LEVELS OF MAIZE OFFAL AS REPLACEMENT FOR MAIZE. I. EFFECT ON PERFORMANCE

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**Target audience:** Livestock scientists, extension staff and farmers.

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### ABSTRACT

Fifteen Large White x Landrace weaner pigs, between 49-56 days of age, averaging  $7.00 \pm 0.26$  kg were used in a 56-day feeding trial to determine the effect of replacing maize with maize offal (at 0, 25 and 50 % of the maize fraction) in the diet on the growth and cost of feed conversion. The diets were isonitrogenous, containing an average of 20 % crude protein. The efficiency with which the 0 and 25 % maize offal (MO) diets were utilized were better ( $P < 0.05$ ) compared to the 50 % MO diet, though the maize-based control diet was the most efficient in terms of the protein efficiency ratio (PER) and feed:gain ratio. The economy of feed conversion showed that the lowest feed cost per kg liveweight gained was observed with the 0 and 25 % diet, which were comparable. The efficient protein utilization by animals on the control (0 % MO) and the 25 % MO diets was a significant explanatory variable for the comparable gain, which was superior ( $P < 0.05$ ) to that obtained with the 50 % MO diet. The results obtained from this study showed that weaner pigs can tolerate up to 25 % (13.09 % MO inclusion) but not 50 % (26.45 % MO inclusion) maize offal as replacement for maize in diets without animal protein supplementation when maize grain is in short supply.

**Key words:** Growth; weaner pigs; maize offal; maize.

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### DESCRIPTION OF THE PROBLEMS

The scarcity of conventional feeds has hindered the growth of the livestock industry in Nigeria. The shortage of energy and protein feeds appears to be more severe for non-ruminants that depend to a great extent on compounded feeds, especially pigs, which are bulk feeders. There are however a number of agro-industrial by-products, farm waste on crop residues, that can be exploited as alternative feed sources for the high energy cereals. This could make a substantial contribution towards

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better and more economic feeding of non-ruminants. Changes needed in the feed supply system to improve the swine production industry was reported by Dean (1). These include utilization of local feedstuff sources, development of agro-industrial waste processing technologies, improved choice of supply of feed to livestock producers and transference of lower cost of feeding technology to farmers.

Maize offal, a by-product of maize processing, is relatively available in large quantities in areas where production and processing occur. Maize offal has a great potential as animal feedstuff as it is not presently used for food by man (2). Consequently, in the face of acute shortage and prohibitive cost of the conventional energy source, this study aimed at reducing the cost of supplying energy to weaner pigs using graded levels of maize offal as a replacement for maize.

## MATERIALS AND METHODS

The experiment was carried out in the Teaching and Research Farm of the Faculty of Agriculture and Forestry, University of Ibadan, Ibadan.

**Source and processing of test ingredient** : The test ingredient was maize offal. It was purchased from the local grain millers in Bodija market, Ibadan and was further dried in the sun to a constant weight before being incorporated into the diets. The other feed ingredients were purchased at Solas-Daras Nigeria Limited, Ojoo and Ola-Omolola Farms, Iwo Road, Ibadan.

**Experimental diets** : There were three dietary treatments in the experiment. They included (a) 0 % maize offal (maize-based, control), (b) 25 % replacement of maize with maize offal and (c) 50 % replacement of maize with maize offal. The maize offal was added to replace 25 or 50 % of the metabolizable energy (ME) supplied by maize in the control diet. The diets were formulated to contain 20 % crude protein. The percentage composition of the experimental diets is shown on Table 1.

**Experimental animals** : Eighteen Large White x Landrace weaner pigs, between 49-56 days of age, averaging  $7.00 \pm 0.25$  kg body weight were used in the 56-day growth trial to evaluate maize offal as a replacement for maize in the diets of weaner pigs. The pigs were injected with Ivomec (R) (Ivermectin) subcutaneously against endo- and ectoparasites (1 ml/50 kg liveweight). They were randomly allotted to the three treatment groups based on body weight, sex and litter origin in a completely randomized design. Each group of six pigs, comprising of three males and three females, were individually penned. All pigs were housed on concrete-floored pens equipped with feeding and watering troughs to allow ad libitum consumption of feed and water, respectively. The weekly weight and feed intake were recorded. Weight gain, dry matter intake, protein intake, feed:gain ratio (feed conversion), protein efficiency ratio,

metabolizable energy intake per day and metabolizable energy intake per gain were recorded.

Table 1. Gross compositions (%) of weaner pig diets with graded levels of maize offal (MO) as replacement for maize.

Ingredient	Level of MO inclusion (%)		
	0	25	50
Maize	51.26	38.59	25.63
Maize offa <sup>1</sup>	0	13.09	26.45
Soybean cake	28.99	28.57	28.17
Palm kernel cake	10.00	10.00	10.00
Brewers' dried grain	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00
Oyster shell	1.00	1.00	1.00
Premix (Vit-min)*	0.25	0.25	0.25
Salt	0.50	0.50	0.50
Total	100.00	100.00	100.00

\* Vit A 10,000,000 IU; Vit D<sub>3</sub> 2,000,000 IU; Vit E 8,000 IU, Vit K 2,000 mg; Vit B<sub>2</sub> 5,500 mg; Vit B<sub>6</sub> 1,200 mg; Vit B<sub>12</sub> 12 mg; Biotin 30 mg; Folic acid 600 mg; Niacin 10,000 mg; Pantothenic acid 7,000 mg; Choline chloride 500,000 mg; Vit C 10,000 mg; Iron 60,000 mg; Mn 80,000 mg; Cu 8,000 mg; Zn 50,000 mg; Iodine 2,000 mg; Cobalt 450 mg; Selenium 100 mg; Mg 100,000 mg; Anti oxidant 6,000 mg.

**Chemical analyses** : The test ingredients and feed samples were analysed for the proximate compositions using the methods of A.O.A.C. (3) and these are shown in Table 2. The MEs were also determined with the prediction equation reported by Morgan et al. (4) based on the proximate compositions.

**Cost estimations** : The cost of the ingredients at the time of purchase was used to calculate the total cost of feed per 100 kg of the diet. This was further used in the estimation of the cost of feed per kg diet (N), cost of feed consumed per day (N) and cost of feed per kg liveweight gained (N).

**Statistical analyses** : All data obtained were subjected to analysis of variance and where statistical significance was observed, the means were compared using the Duncan's multiple range test. The regression analyses of the performance parameters (X) as dependent on daily weight gain (Y) by treatment were determined to form prediction equations. The SAS computer software package (5) was used for all statistical analyses.

Table 2. Proximate composition (% DM basis) of maize offal and the test weaner diets.

Item	0 % MO	25 % MO	50 % MO	MO
<b>Dry matter analyses</b>				
% of DM	89.20	86.00	86.20	89.70
Crude protein	20.65	20.35	20.70	10.15
Crude fibre	4.73	6.05	7.35	9.20
Ether extract	7.80	6.20	5.20	2.60
Ash	8.00	7.50	8.80	1.50
Nitrogen free extract	58.82	59.99	57.95	76.55
ME (Kcal/ME/kdg)*	3532.38	3374.52	3086.90	3292.86

\* Estimated by prediction equation (4).

## RESULTS AND DISCUSSION

**Performance characteristics** : The summaries of the performance characteristics as affected by the level of MO in the diets are shown in Table 3. The pigs on the 50 % level of MO inclusion with average daily gains of  $0.32 \pm 0.01$  kg grew at a significantly ( $P < 0.05$ ) lower rate when compared to those on the other two levels which had comparable growth rates. The average daily dry matter intake at the 50 % MO inclusion was significantly ( $P < 0.05$ ) higher than at the other two levels of MO inclusion. The average daily protein intake which was a function of the feed intake followed the same trend as feed intake. The feed conversion or feed:gain ratio was significantly ( $P < 0.05$ ) depressed by increasing the levels of MO inclusion. The protein efficiency ratio or efficiency of protein utilization was also significantly ( $P < 0.05$ ) depressed with increasing levels of MO inclusion in the various diets.

ME intake per day decreased ( $P < 0.05$ ) with increasing levels of MO inclusion in the diets. However, the average ME intake per kg gain for the 50 % level of inclusion was significantly ( $P < 0.05$ ) higher than those of pigs on the maize-based diet but similar to those on the 25 % MO inclusion. The average ME required per unit gain at 0 and 25 % MO levels were also comparable, hence the energy efficiencies for the two levels of MO inclusion were similar.

The regression equations showing the levels of dependence of some performance traits on daily weight gain for each of the levels of MO inclusion are shown in Table 4. The daily weight gains of the pigs on the maize-based control diet was significantly and positively affected ( $P < 0.01$ ) by the daily protein intake and efficiency of protein utilization (PER) while

Table 3. Performance of weaner pigs fed graded levels of maize offal as replacement for maize in diets.

Parameter	Level of maize offal inclusion (%)		
	0	25	50
Daily weight gain (kg)	0.38 ± 0.009 <sup>a</sup>	0.35 ± 0.013 <sup>a</sup>	0.32 ± 0.010 <sup>b</sup>
Daily dry matter intake (DDMI) (kg)	0.78 ± 0.026 <sup>b</sup>	0.79 ± 0.028 <sup>b</sup>	0.84 ± 0.028 <sup>a</sup>
Daily protein intake (DPI) (kg)	0.16 ± 0.005 <sup>b</sup>	0.16 ± 0.006 <sup>b</sup>	0.17 ± 0.006 <sup>a</sup>
Feed gain ratio (FGR)	2.10 ± 0.074 <sup>c</sup>	2.31 ± 0.095 <sup>b</sup>	2.71 ± 0.095 <sup>a</sup>
Protein efficiency ratio (PER)	2.55 ± 0.104 <sup>a</sup>	2.32 ± 0.088 <sup>b</sup>	1.96 ± 0.072 <sup>c</sup>
ME intake per day (MEID)	2747.31±91.656 <sup>a</sup>	2660.74±93.923 <sup>b</sup>	2594.54±87.290 <sup>c</sup>
ME intake per kg gain (MEIG)	7411.39±262.016 <sup>b</sup>	7802.63±318.732 <sup>ab</sup>	8357.13±292.435 <sup>a</sup>

abc: Means along the same row differently superscripted differ significantly ( $P < 0.05$ ).

those on the diet with 25 % MO were highly significantly ( $P < 0.001$ ) dependent on PER. However, gains of pigs on the 50 % replacement level were not significantly influenced by any of the measured performance parameters.

Table 4. Linear regression equations of some performance traits as dependent on daily weight gain (Y).

MO content (%)	Regression equations	R <sup>2</sup>
0	$Y = -0.260 - 1.277DDMI + 19.278DPI + 0.107FGR + 0.022PER - 0.591MEID - 0.073MEIG$ (0.047) (2.624) (6.665) (0.477) (0.009) (0.547) (0.137)	0.970
25	$Y = -0.107 - 3.054DDMI + 12.100DPI + 0.575FGR + 0.091PER - 0.332MEID - 0.073MEIG$ (0.093) (4.710) (11.148) (0.900) (0.091) (1.015) (0.271)	0.967
50	$Y = -0.019 - 2.306DDMI + 1.323DPI - 0.565FGR + 0.125PER + 0.785MEID + 0.177MEIG$ (0.067) (3.203) (8.602) (0.337) (0.016) (0.782) (0.111)	0.962

\*\* ( $P < 0.01$ ) and \*\*\* ( $P < 0.001$ )

Figures in brackets are standard errors of regression coefficient

Results from this study showed that the lower energy concentration of the 50 % MO diet led to increased dry matter intake as the pigs attempted to meet their energy requirement by consuming more of the feed. Increased feed intake has been reported to generally result from the pig's attempt to maintain the digestible energy (DE) intake (6,7). The increased dry matter intake of pigs on 50 % MO diet was however not justified by higher growth rate as a lower weight gain was observed. This could be attributed to the high fibre content of the diet. Coffey et al. (8) and Stahly (9) reported that high fibre diets depressed growth rate during periods of high temperatures, which is a prevalent situation in the tropics. Fibrousness has been reported (10) as a feature of most locally available agro-industrial by-products and wastes that limits their use. The physical bulk may affect the overall retention time of digests in the gastrointestinal tract and consequently their utilization (11,12). The highest weight gain occurred with the maize-based control diet which had similar value with those of pigs on the 25 % MO diet.

The diets were formulated to be isonitrogenous and variations observed in protein intake were due to feed intake. Hence the protein intake in pigs increased ( $P < 0.05$ ) with increased dry matter intake. It has been established that pig performance in terms of rate and efficiency of gain is closely related to the nutrient intake levels, especially protein and energy (13, 14). However, the high protein intake of the pigs on the 50 % MO diet was not accompanied by a commensurate weight gain, probably as a result of the fibrousness of the diet caused by increased MO inclusion. The fibrous portion of feed exerted a protective action, encasing other nutrient constituents in a digestion-proof shield (15).

This fibrousness resulted in the lowered ME intake per day for the pigs on the 50 % MO diet due to the dilution of the energy concentration of the diet (10, 16). Hence a poor efficiency of energy utilization in terms of increased ME intake per liveweight gain relative to the 0 and 25 % MO diets. From the result obtained in this study, it was evident that a higher ME was required for a kg liveweight gained for pigs on the 50 % MO diet compared with pigs fed the control diet.

The best efficiency of utilization of the feed and its protein was obtained with the control diet. This decreased with increased fibre in the diet resulting from the increased MO inclusion. Efficiency of feed conversion in pigs has been found to be inversely related to increased feed intake level because higher intake allows for increased body fat deposition (17) and body fat deposition requires more energy than protein (muscle) deposition for the same unit increase in body weight (18).

PER, which is a measure of the quality of the protein of the feed, showed that the protein in the control diet was of higher quality in view of its efficient utilization compared to the MO diets. The diet with the 25 % MO inclusion was in turn more efficient than that of 50 % MO. PER was reported as an index of protein utilization for growth and that any factor

which influences the rate of growth may markedly affect the PER (19). The results of this study showed that maize in the diets of weaner pigs can be replaced with MO up to 25 % without any adverse effect on the performance of the pigs.

The result of the regression analysis as shown with the regression equations for the three levels of MO inclusion also indicated that the efficient utilization of the ingested protein significantly determined the growth rate in terms of weight gains for pigs on the maize-based control and the 25 % MO diets but not at the 50 % MO inclusion. At the 50 % MO inclusion level, none of the variables considered significantly influenced the daily weight gains. The efficient protein utilization at the control and the 25 % MO level supported the superior weight gains at these levels compared to gains of the pigs on the 50 % MO diet. This agreed with earlier findings (13, 14, 20) in which the rate and efficiency of gains were reported to be closely related to the nutrient intake and utilization.

**Economy of production** : The economy of production as expressed by feed consumed per day and the cost of feed consumed per kg liveweight gain is shown in Table 5. The cost of feed consumed per day decreased ( $P < 0.05$ ) with increasing replacement of maize with MO up to 25 % level. The cost of feed consumed per day at 25 % MO inclusion was comparable to that obtained at 50 % level. The cost of feed per kg liveweight gained was not significantly affected by the dietary treatment up to 25 % level. However, the value of 50 % inclusion was significantly ( $P < 0.05$ ) higher than those for 0 and 25 % inclusions.

Table 5. Economy of production of weaner pigs fed graded levels of maize offal as replacement for maize in diets.

Parameter	Level of maize offal inclusion (%)		
	0	25	50
Feed cost/kg diet (N)	8.10	7.67	7.23
Feed cost of feed consumed per day (FCD)(N)	6.30 ± 0.21 <sup>a</sup>	6.05 ± 0.21 <sup>b</sup>	6.08 ± 0.21 <sup>b</sup>
Cost of feed/kg liveweight gain (FCLWG)(N)	17.00 ± 0.60 <sup>b</sup>	17.74 ± 0.72 <sup>b</sup>	19.57 ± 0.69 <sup>a</sup>

ab: Means on the same row differently superscripted differ significantly ( $P < 0.05$ ).

As can be observed from the results, the cost per kg diet decreased numerically with increasing MO inclusion. This could be attributed to the replacement of the more expensive maize (N5.00/kg) with the relatively

cheaper MO (N2.00/kg) (During the conduct of the study in 1993). MO has been reported to be a cheaper energy source (2, 10, 21).

Despite the higher feed intake observed with pigs on the 50 % MO diet, the average cost of feed consumed per day, which was comparable to those of pigs on the 25 % MO diet, was lower than for pigs on the maize-based diet. However, the cost of feed required to gain a kg liveweight on the 50 % MO diet was higher than that required on the 25 % MO diet, which was comparable to that of the maize-based control diet. This reflected the real production value of the test diets for the growing pigs, which was closely associated with feed utilization as noted earlier (22). Even when they consumed more of the relatively cheaper diet, the diet could not be efficiently utilized to support good growth rate. This was evident in the higher cost required to gain a kg body weight using the diet containing 50 % MO for this class of pigs. Phillips (23) reported that reducing feed cost was not only to obtain cheaper feed but was also dependent on the production result obtained with this cheaper feed. He therefore concluded that the efficiency with which the feed was utilized was of major importance.

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